limited to national interests or whose point of view is purely economic have not discovered it. Pacifist, eugenist and feminist all miss it. Rather is it known only by those "who are beginning to perceive that the social problem is now what it has been in all ages, namely the problem of the relations of men to one another." These relations are the outcome of concrete historical, physical, physiological, economic and ideal elements. For example, on the historical side the relations of men in western civilization are largely determined by inheritance of Greek, Hebrew, Roman and Teutonic customs and ideals. Briefly attempting to characterize some of the chief contributions of each of these factors, the author endeavors to show how various inharmonious elements in them have combined with specified unfortunate effects of physical and economic influences to produce undesirable conditions in present society. A final chapter, on "The Solution of the Social Problem," lays down a number of precepts. To "solve" the social problem we must take a synthetic view of our social life, avoid revolution and violence, develop sympathy among all classes in the population, advance education, purify family life, control heredity, inculcate social responsibility, stress reason and altruism, support science, readjust the economic system and finally as a means to all this find and train social leaders.

In covering so large a field in so short a volume Professor Ellwood has necessarily dealt in cavalier fashion with most of his topics. In consequence the cautious scientist who looks in this book for adequate proof of all positions taken will be disappointed. The discerning reader, nevertheless, may possibly draw the not-unscientific conclusion from it that the world is still full of a number of things that need careful investigation. It is to be feared, however, that not all into whose hands "The Social Problem" falls will be able to distinguish opinions from generalizations that have been established through the work of numerous investigators.

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SPECIAL ARTICLES

NEW METHODS IN SOIL PROTOZOOLOGY[1]

In the investigation of a problem bearing on the conclusions of Russell and Hutchinson[2] who consider protozoa as one of the limiting factors of bacterial activity and consequently of soil fertility, the authors found it expedient to carry on several preliminary experiments for the purpose of establishing the value of certain newly devised methods.

In view of the fact that the methods employed for counting protozoa have been unsatisfactory even in the hands of such experienced investigators as Rahn,[3] using an application of the bacterial dilution method; Killer[4] plating on solid media; Müller[5] counting protozoa per standard loopful of solution; and numerous others counting the protozoa directly in a drop by means of a microscope; the authors have adapted the well-known blood-counting apparatus (Blutkörperzählapparat) to the counting of protozoa. The principle underlying the use of this instrument is the microscopical observation of a drop of standard size. The organisms may be examined in the stained or unstained, in the living or dead state. Picrosulphuric acid (Kleinenberg) is recommended for killing and rapid staining simultaneously.

The calculation of results is based on the use of a standard stage micrometer, the squares marked on the disc of the slide, and the constant depth of solution under observation, which is .1 mm. Thus no mechanical variation is possible. The advantages of using this apparatus for counting protozoa are as follows:

1. It is a direct method, thus eliminating many errors attending incubation, etc., and the results can be reported immediately.

[1] From the laboratories of Protozoology and Soil Bacteriology. Further results of experimentation and a bibliography on soil protozoology and soil sterilization are awaiting publication in coming issue of *Centr. f. Bakt.*, Abt. II.

[2] Russell and Hutchinson, *Jour. Agr. Sci.*, 3 (1909), 111; *ibid.*, 5 (1913), 152, etc.

[3] Rahn, O., *Centr. f. Bakt.*, II., 36 (1913), 419.

[4] Killer, *Centr. f. Bakt.*, II., 37 (1913), 321.

[5] Müller, *Archiv. f. Hyg.*, 75 (1912), 321.

2. It is more accurate than any other method in use, because it is a standard instrument and no mechanical variation is possible.

3. It is rapid and saves considerable time in contradistinction to other methods, and the technique is simple. For example, triplicate counts on any medium were recorded in ten minutes.

4. The counts check more closely than those of any other method.

5. It can be used to advantage whether the number of protozoa present be large or small.

6. It can be used for living, killed or stained organisms and permits of a thorough observation of the individual organisms.

Its disadvantages are that the initial cost is greater than that of other methods, and the sample is too small to be representative. The error of count is considerable where the protozoa are very few or many in number. And a number of fields must be counted because of the uneven distribution, if an accurate count is required.

Despite the logical thoroughness of Russell and Hutchinson's work, there appears to be one point which they seem to have neglected. Namely, the production of ammonia, etc., is used as a criterion for measuring the effect of soil protozoa on bacterial activity, while the fungi in the soil, which are known to be capable of producing ammonia,[6] were not taken into account. Thus there is an added unrecognized factor operating in their experiments as well as those of others, *i. e.*, soil fungi.

Taking cognizance of this factor, a method was devised for its elimination, based upon the principle of dilution, in such a way as to reduce the possibilities for the occurrence of fungi. The method of procedure was to pour plates of ten different fungi media in duplicate. These agars were: potato, oat, cornmeal, rice, bean, raisin, apple, synthetic, soil extract and Cook and Taubenhaus's No. 2.[7]

Upon cooling, a block of each medium about 2 cm. square was cut out with a sterile knife, and 1 c.c. of sterile soil extract was introduced by means of a sterile pipette into the cavity formed. A platinum loopful of a three-day-old culture of soil organisms in soil extract, known to contain numerous bacteria, protozoa and fungi, was then carefully rinsed off in the medium occupying the cavity.

At the same time poured plate cultures of one loopful of the three-day-old culture of organisms were made on the ten different agars mentioned above. Likewise after one week poured plate cultures were made on the ten different media by inoculation with one loopful of the solution present in the cavity of the agar plate.

The results show that on the plates where a portion of the agar was removed and 1 c.c. of soil extract substituted, the bacteria and protozoa developed in large numbers, which might in all probability be due to the fact that a large surface is exposed for such a small quantity of media. The important point, however, which is to be noted from this experiment is that despite the fact that suitable media were furnished for the growth of fungi, none was evident, even after thirty days' incubation.

From the observation of the poured plate cultures made from the original three-day-old culture we note that fungi appear after four days upon three out of ten plates; namely, No. 2, synthetic,[8] and raisin agars. The fungi predominating were species of *Penicillium*, *Alternaria* and *Fusarium*.

On the poured plate cultures made from the solution in the cavity of the agar plates, no fungi developed. This experiment was repeated and corroborated the previous results.

Thus it is certain that whereas fungi were present in the original culture the process of high dilution was responsible for their elimination from the specially prepared cavity on the agar plates.

Thus the dilution method followed by the peculiar manner of plating, as outlined, makes it possible to separate fungi from bacteria and

[6] Müntz and Coudon, *Compt. Rend.*, 116 (1893), 395.

[7] Cook and Taubenhaus, Dela. Bull. No. 91 (1911), 11.

[8] Lipman and Brown, N. J. Ann. Rpt. (1908), 132.

protozoa. And as a result of this separation, it is possible to eliminate fungi from experiments involving the effect of protozoa upon bacterial activity, by making a subculture from the fungi-free solution of bacteria and protozoa (in the cavity of the agar plate).

Some studies on the comparative value of different media for the development of soil protozoa, somewhat after the manner of Cunningham and Löhnis[9] and others, were carried out with hay infusion, with and without the addition of .5 per cent. egg albumen (Goodey), peptone, dried blood, soil extract (Löhnis), horse, cow and chicken manures (Martin) and egg albumen. The above media were employed in dilutions of .5 per cent., 1 per cent., 3 per cent., 5 per cent. and 10 per cent.

A condensed table[10] of maximum numbers (counts made on five succeeding days by means of the Blutkörperzählapparat previously described) is given below:

Days	Large Ciliates	Large Flagellates	Small Ciliates	Small Flagellates
1	8,520 in soil ex. 800 cc.	840 in 10 % hay	4,255 in 5% D. B.	28,750 in 5 % D. B.
2	63,800 in horse .5 %	709 in 5 % egg albumen	9,210 in 3% chicken	282,000 in 5 % horse
3	319,010 in 10 % hay	10,625 in 10 % hay	208,000 in 3 % chicken	636,500 in soil ex. 1,000 cc.
4	708,000 in 10 % hay	7,435 in 5 % cow	379,000 in 3 % egg	478,000 in 1 % horse
5	1,410,000 in 10 % hay and egg	319,000 in 5 % cow	804,000 in 3 % egg	1,878,000 in 3 % hay and egg

Summary

1. Ten per cent. hay infusion proved to be the most favorable medium for the development of large numbers of small flagellates, as well as small and large ciliates. Hay infusion in various concentrations, with and without the addition of egg albumen, proved to be well adapted to the development of the organisms. Hay infusion plus .5 per cent. egg albumen proved superior to all other media for the development of ciliates.

2. Soil extract is an excellent medium, though somewhat inferior to hay infusion plus .5 per cent. egg albumen and with the soil used in this experiment lower concentrations than those recommended by Löhnis, developed protozoa in a shorter period of time.

3. Three per cent. chicken manure is an excellent medium for the development of small ciliates.

4. The numbers and species of protozoa which can be obtained from a given soil are largely dependent upon the media employed, time of incubation, as well as the kind of soil used.

5. In general the order of appearance of protozoa was as follows: small flagellates, small ciliates, large flagellates (if appearing at all) and finally large ciliates. This confirms Cunningham and Löhnis's observations.

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H. CLAY LINT,
DAVID A. COLEMAN

NEW BRUNSWICK, N. J.,
February 25, 1915

[9] Cunningham and Löhnis, *Centr. f. Bakt.*, II., 39 (1914), 596.

[10] Kopeloff, Lint and Coleman, *Am. Mic. Soc.*, 34, No. 2 (1915), 149, *Jour. Agr. Res.*, 4, No. 6 (1915).

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE Botanical Society of Washington entertained at an informal dinner at the Cosmos Club, on Thursday evening, July 22, 1915, Dr. F. Kølpin Ravn, of Denmark, Dr. Otto Appel, of Germany, and Dr. Gentaro Yamada, of Japan. Mr. M. A. Carleton welcomed the guests, each of whom responded.

Dr. H. B. Humphrey commented on the services rendered to cereal pathology by Dr. Ravn's travel and studies in the United States this season.

Dr. W. A. Orton gave a full account of the travel of Dr. Appel and his investigations of the potato diseases in this country during the past year.

Dr. E. F. Smith emphasized the importance of wide travel and experience to botanical investigators.

Dr. C. L. Shear spoke on international phytopathology, and expressed a hope that within a short time there may be organized an international society of plant pathologists.

PERLEY SPAULDING,
Corresponding Secretary